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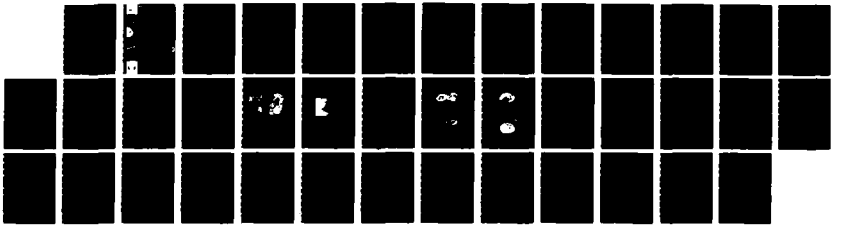

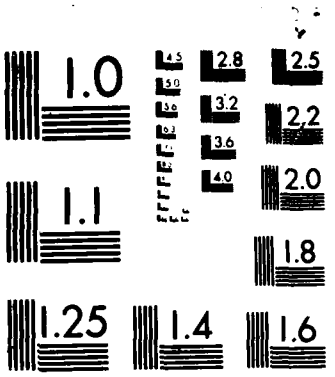

US Army Corps of Engineers

MISCELLANEOUS PAPER EL-87-5

A SURVEY FOR MOLLUSCS IN THE WHITE RIVER NEAR NEWPORT, ARKANSAS, 1986

by

Andrew C. Miller

Environmental Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

and

John L. Harris

Arkansas State Highway
and Transportation Department
Little Rock, Arkansas 72203

June 1987
Final Report

ENVIRONMENTAL LABORATORY

Prepared for US Army Engineer District, Memphis
Memphis, Tennessee 38103

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Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date Jun 30 1986

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b DECLASSIFICATION / DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) Miscellaneous Paper EL-87-5	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION See reverse 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code) PO Box 631, Vicksburg, MS 39180-0631 Little Rock, AR 72203	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING / SPONSORING ORGANIZATION USAED, Memphis 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code) Memphis, TN 38103	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)
A Survey for Molluscs in the White River Near Newport, Arkansas, 1986

12 PERSONAL AUTHOR(S)
Miller, Andrew C., Harris, John L.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final report	FROM _____ TO _____	June 1987	38

16 SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Arkansas, Endangered species, Dredging, Molluscs

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A survey for live molluscs and shells was made on 27-30 October 1986 in the White River, near Newport, Arkansas, river mile 254.6 to 230.7. Molluscs were collected at 12 dredged material disposal sites using divers equipped with SCUBA, and by hand on shore and in shallow water. Twenty-four species of unionid molluscs, in addition to the Asiatic clam, *Corbicula fluminea*, were collected alive and seven additional species were found only as shells. The existing fauna is dominated by thick-shelled species, [illegible] (36.0 percent), *Fusconaia ebena* (22.4 percent), [illegible] (9.9 percent), *Lampsilis altilis* (7.3 percent), and *Obliquaria reflexa* [illegible]. Live species that made up less than 1 percent of the community included [illegible], *Cyprogenia aberti*, [illegible], [illegible], [illegible], *Quadrula nodulata*, and *Truncilla truncata*. Live mussels were found in 1- to 2-m linear strips of sand and gravel within 30 m of shore, or in

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20 DISTRIBUTION / AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

6a. NAME OF PERFORMING ORGANIZATION (Continued).

USAEWES Environmental Laboratory
Arkansas State Highway and Transportation Department

19. ABSTRACT (Continued).

depositional zones with mud substrate. The endangered *Potamilus capax* and *Lampsilis orbiculata* were not collected alive; however, relict shells of the latter species were found at seven sites. Fresh *L. orbiculata* shells were collected at river mile 236.2 where previous workers reported finding this species alive. Other important sites on this reach of the White River for mussels are at river miles 250.0 (left descending bank) and 241.9 (right descending bank). The mussel fauna in this reach of the river has been stressed by maintenance dredging and to some extent by commercial harvesting and hypolimnetic reservoir releases upriver. However, evidence of recent recruitment was found for 10 species of unionids, many of which were collected in close proximity to previously dredged areas.

Keywords: marine biology; ecology; habitat; ecosystems.

PREFACE

On 27-30 October 1986 a survey was conducted on the White River, Jackson and White Counties, Arkansas, for freshwater mussels (Mollusca:Unionidae). The purpose of the study was to collect information on mussels for the US Army Engineer District, Memphis (LMM), to be used for decisions concerning the environmental effects of maintenance dredging at selected sites between river miles 254.6 and 230.7 on the White River. This report was prepared by Dr. Andrew C. Miller, US Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, and Dr. John L. Harris, Arkansas Highway and Transportation Department, Little Rock, Arkansas. Additional assistance was provided by Dr. Morris Mauney, LMM; Mr. Manual Barnes, US Army Engineer District, Little Rock; and Mr. Jim Stewart, US Fish and Wildlife Service, Jackson, Mississippi. Messrs. Robert Leisure and Raymond Spicer, Grand Glaise, Arkansas, provided information on existing and past mussel resources in the river. The following divers from Lake Dardanelle, Arkansas, collected mussels during the survey: Messrs. Jerry Howard, Sam Jones, and Spencer Cox. The report was edited by Ms. Jamie W. Leach of the WES Information Products Division.

This report was conducted under the general supervision of Mr. Richard Coleman, Acting Chief, Aquatic Habitat Group; Dr. Conrad J. Kirby, Chief, Environmental Resources Division; and Dr. John Harrison, Chief, Environmental Laboratory, WES.

Commander and Director of WES was COL Dwayne G. Lee, CE. Technical Director was Dr. Robert W. Whalin.

This report should be cited as follows:

> Miller, A. C., and Harris, J. L. 1987. "A Survey for Molluscs in the White River near Newport, Arkansas, 1986," Miscellaneous Paper EL-87-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
feet	0.3048	metres
miles (US statute)	1.609347	kilometres
tons (2,000 pounds, mass)	907.1847	kilograms

A SURVEY FOR MOLLUSCS IN THE WHITE RIVER NEAR NEWPORT, ARKANSAS, 1986

PART I: INTRODUCTION

Background

1. Freshwater mussels are a renewable resource with economic, cultural, and ecological value. Their meat has been used for food and the shells as ornaments, tools, and pearl buttons. Because they are long lived and practically nonmotile, their presence at a site provides evidence of previous habitat conditions. They are useful laboratory organisms for bioassay studies and research on sublethal and lethal stress. There are over 200 species of freshwater mussels in this country, and, of these, 25 are on the Endangered Species List prepared by the US Department of Interior.

2. These invertebrates live in ponds, lakes, streams, and large rivers. They frequently dominate the benthic fauna, both in numbers and biomass. They inhabit a variety of substrates including mud, silt, sand, and gravel, or between and under large rocks. However, they are most likely to be found in gravely sands in medium- to large-sized rivers in the central and eastern United States. Depositional areas, such as gravel shoals or bars, have stable substrate and moderate current velocities which bring in food and oxygen, and remove wastes and recently settled sediment.

3. In this country the largest commercial use of mussel shells is for the cultured shell industry. The three-ridge (*Amblema plicata*), washboard (*Megalonaias gigantea*), ebony shell (*Fusconaia ebena*), or Ohio River pigtoe (*Pleurobema cordatum*) are collected from rivers in the eastern United States. The meat is removed and the shells shipped to the Orient where they are cut into cubes, then ground into spheres and inserted into an oyster as a nucleus for a cultured pearl. Live mussels are collected by diving, infrequently by wading in shallow water, or by dragging a brail from behind a boat. A brail consists of several hundred four-pronged hooks attached to a wooden or metal bar 3 to 7 m long. Live mussels will clamp shut on a hook when it slips between the partially opened shells.

Purpose and Scope

4. The purpose of this study w s to collect and identify live freshwater mussels and shells (Mollusca:Unionidae) at selected sites on the White River, Jackson and White Counties, Arkansas, between river miles 254.6 and 230.7 (Table 1). Specific attention was directed to the pink mucket (*Lampsilis orbiculata*), listed as endangered by the US Fish and Wildlife Service. Sites chosen for study are dredged by the US Army Engineer District, Memphis, to maintain commercial navigation traffic.

Study Area

5. The major source of the White River is from the outlets of Bull Shoals and Norfork Lakes (although other lakes contribute), located principally in Marion and Baxter Counties, north-central Arkansas. The river flows in a southeasterly direction until it reaches Newport (Figure 1), then it turns south and eventually enters the Mississippi River in Desha County, Arkansas.

6. Discharge in the White River has been regulated to some extent by Beaver Lake since 1963, Norfork Lake since 1943, Bull Shoals Lake since 1951, and Clearwater and Table Rock Lakes, Missouri, since 1948 and 1956, respectively. The maximum discharge at Newport for the period of record was 343,000 cfs* (17 April 1945), and the minimum discharge was 2,870 cfs (27-30 September 1954). Maximum gage height at Newport was 35.9 ft on 18 April 1945. Average discharge for 52 years of record was 22,800 cfs. Mean discharge and gage height at Newport during this study period are listed below:

Date	Discharge, cfs	Gage Height, ft
27 Oct	8,410	1.96
28 Oct	7,770	1.50
29 Oct	7,770	1.52
30 Oct	9,390	2.69

* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

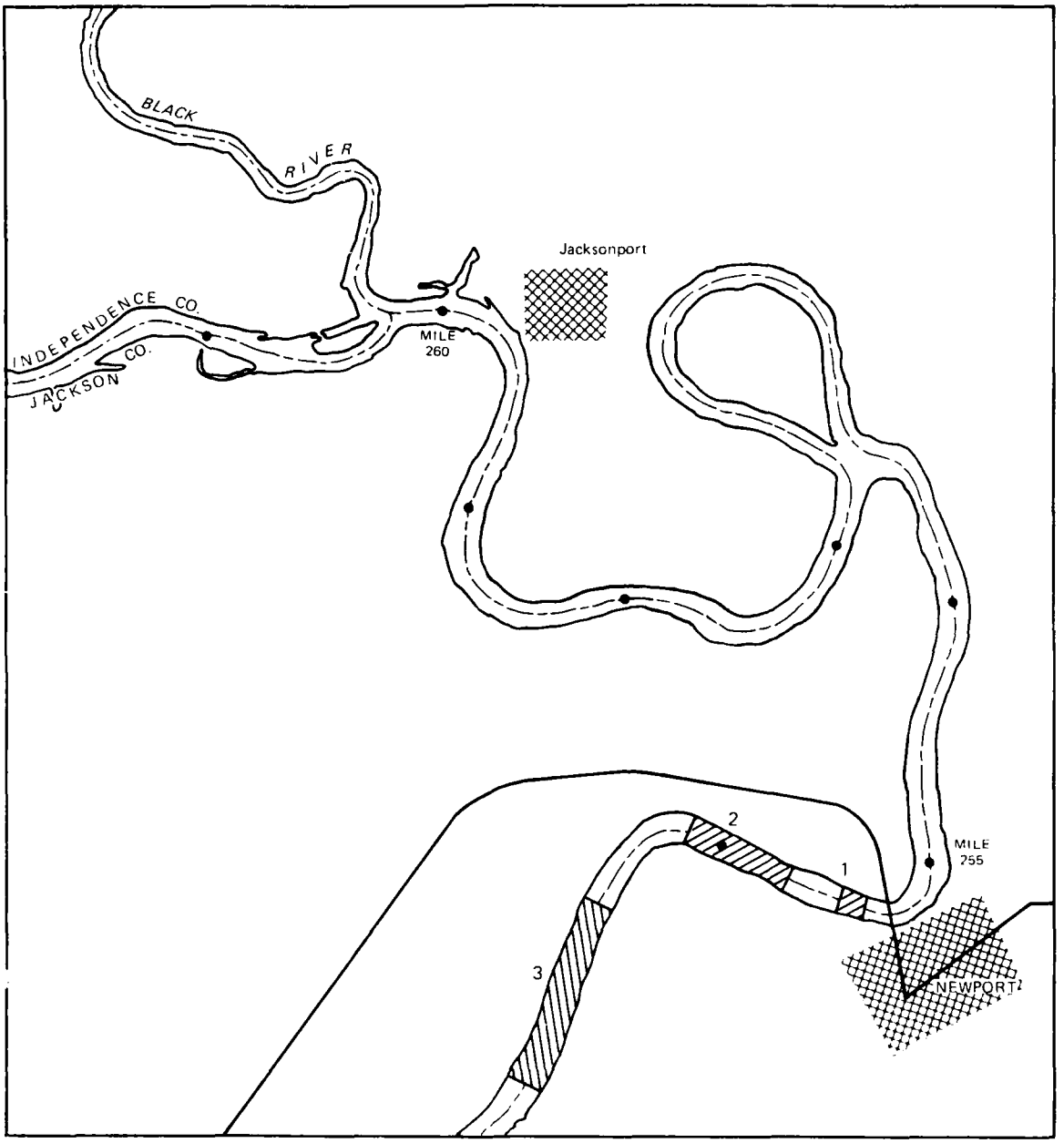

Figure 1. Sites surveyed for molluscs on the White River near Newport, Arkansas, river miles 254.6 to 230.7, Jackson and White Counties, 27-30 October 1986 (Sheet 1 of 4)

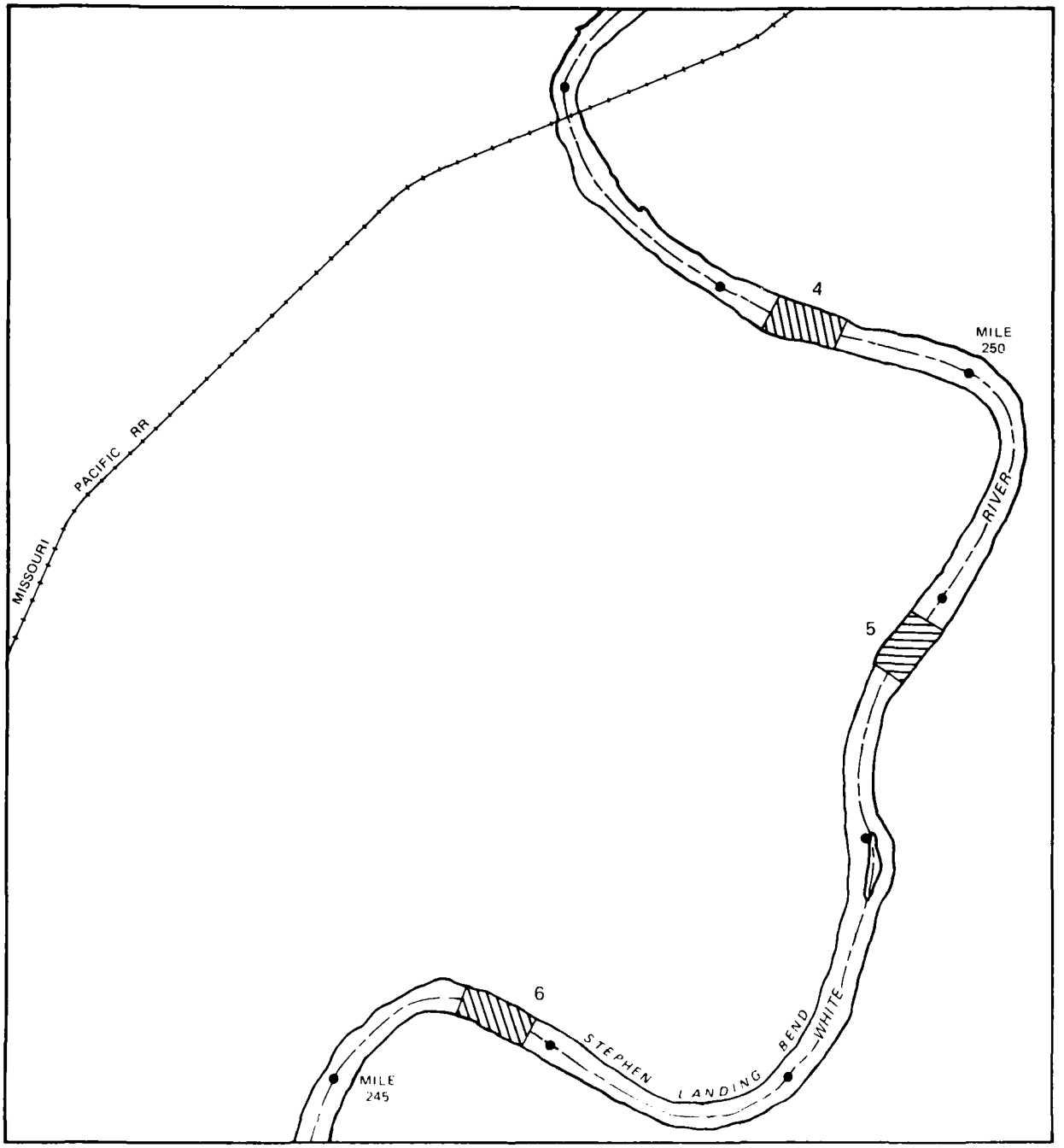

Figure 1. (Sheet 2 of 4)

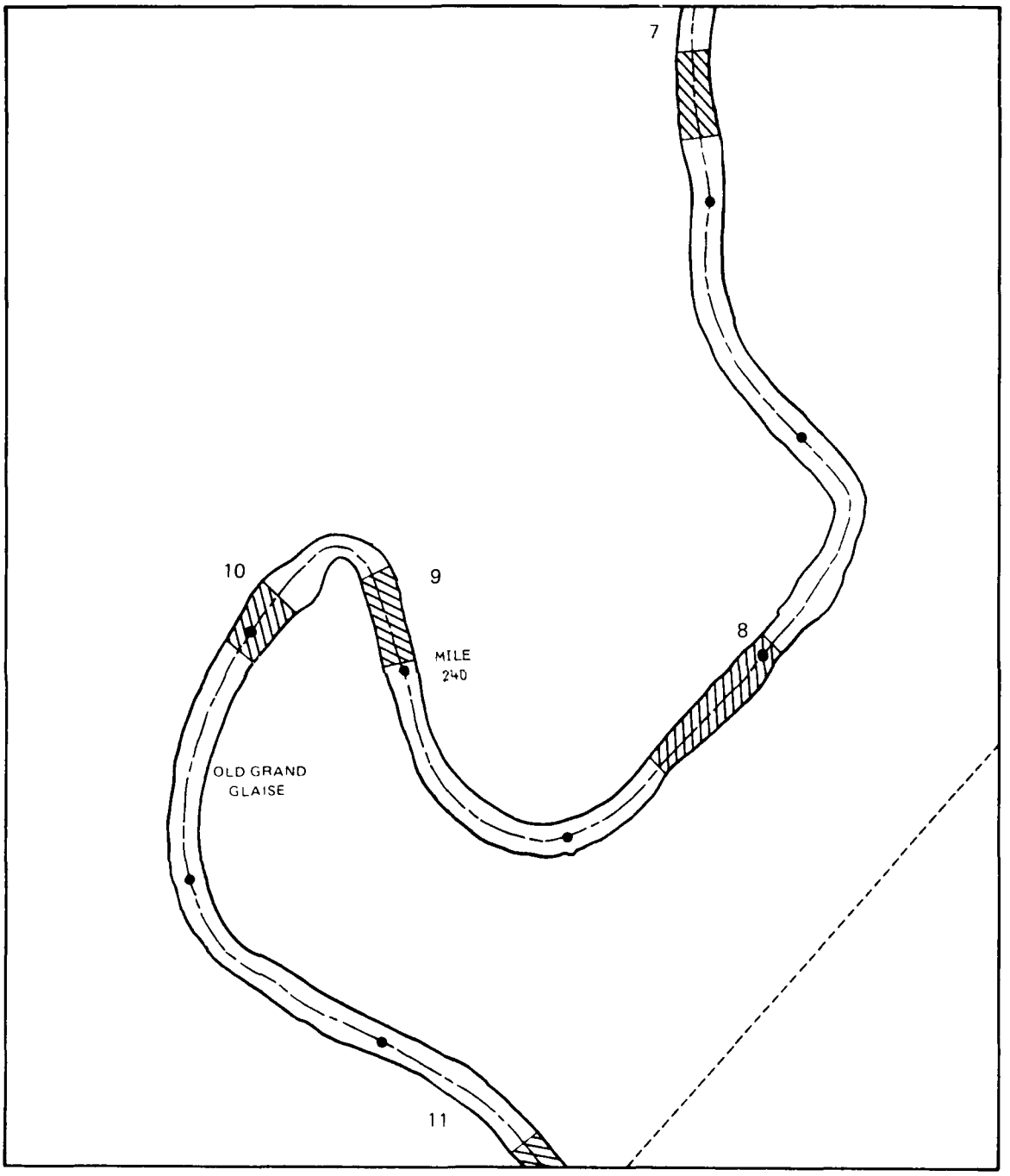

Figure 1. (Sheet 3 of 4)

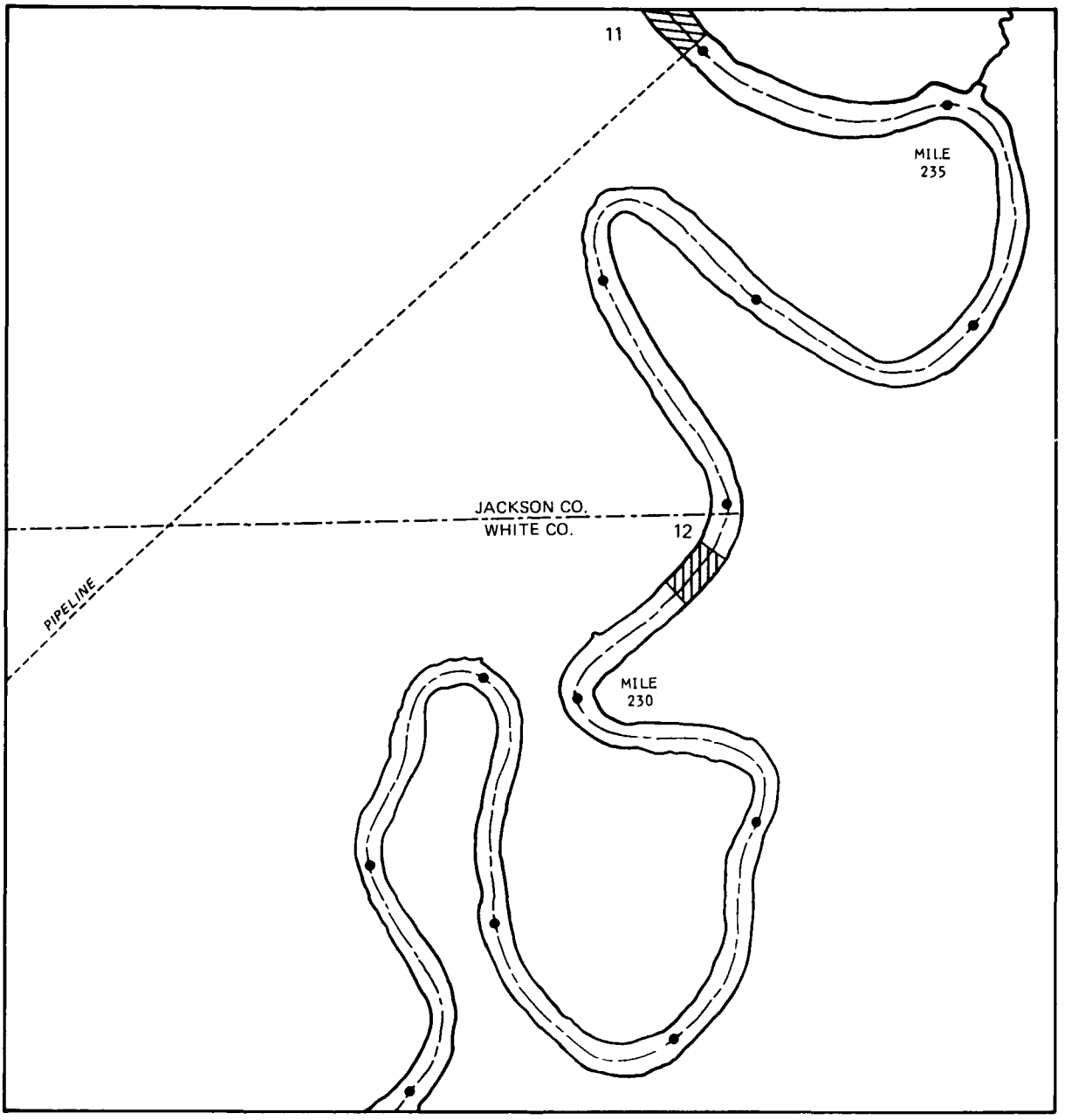

Figure 1. (Sheet 4 of 4)

7. The following is a summary of pertinent chemical data collected every other month from November 1984 to August 1985 (N = 6): specific conductance (154-269 mho/sq cm), pH (7.7-8.2), turbidity (3.5-70 JTU*), dissolved oxygen (7.7-10.8 mg/ℓ), total hardness as calcium carbonate (100-130 mg/ℓ), total alkalinity as calcium carbonate (28-130 mg/ℓ), sulfate (4.8-10.0 mg/ℓ), calcium (24-30 mg/ℓ), and magnesium (7.4-14.0 mg/ℓ). Nitrate plus nitrite nitrogen ranged from 0.23 to 0.53 mg/ℓ as N, and total phosphorus from <0.010 to 0.050 mg/ℓ as P (US Geological Survey 1985).

8. Hypolimnetic releases from Bull Shoals and Norfork Lakes reduce water temperature in the tailwater to 6° to 17° C annually (Hoffman and Kilambi 1971) creating a trout fishery (Aggus, Moraia, and Baker 1978). Summer water temperatures stay below 20° C at the outlet of Bull Shoals Lake, river mile 418.6, and at Calico Rock, Arkansas, river mile 359.1 (Figure 2). However, at Newport and Clarendon, river miles 257.6 and 100.1, respectively, water usually exceeds 20° C from June to November.

9. The study area began at Newport and extended about 25 miles downriver to river mile 230.7 (Figure 1). This is the uppermost portion of the White River Navigation System; commercial traffic terminates at Newport. This reach of the river was opened to commercial traffic in the early 1970's and required extensive dredging. The navigation system is maintained by dredging every year, or once every 2 or 3 years at 12 locations (Table 2). Hydraulically dredged material is deposited in shallow water or on exposed shoals. Disposal piles, which consist of sand, gravel, and dead shells, vary in length from several metres to over 2 km; height above low water level ranges from several centimetres to 4-5 m.

Historical Background

10. One of the earlier reported mollusc surveys in the White River in Arkansas was conducted by Hinkley (1916). Gordon, Kraemer, and Brown (1979), reviewed existing literature and museum records, and Gordon (1982) sampled at 13 sites between Lake Sequoya and St. Charles. Gordon (1982) reported that 64 of the originally known 100 species from the White River have been collected in recent sampling. Kraemer (1980) collected molluscs and other benthos in

* JTU = Jackson Turbidity Units.

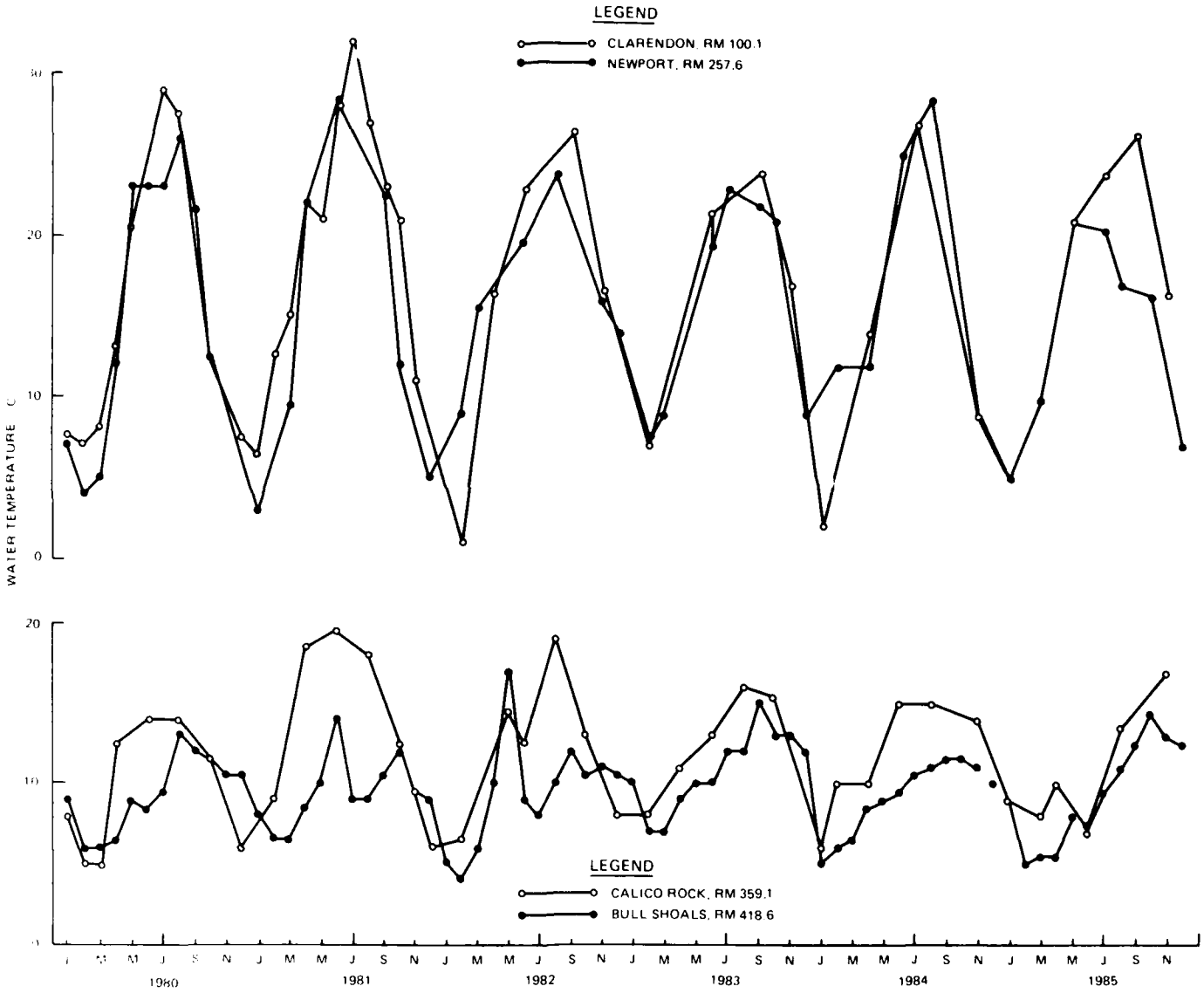

Figure 2. Water temperature data for selected stations on the White River, Arkansas, 1980-1984

the White River at St. Charles, Arkansas County (south of the study area). She collected 17 species of unionids and the Asiatic clam *Corbicula fluminea*, although no Federally listed endangered species were obtained. Stein and Stansbery (1980) used a brail and a hard hat diver to collect live molluscs from a bridge construction site in Jackson County. The bridge, located at river mile 236.2 in the present study area, was recently completed. Stein and Stansbery collected 25 species including two specimens of the endangered mollusc *L. orbiculata*.

11. Between 1912 and 1914 the commercial shell industry in Arkansas was responsible for half of the yearly production from the Interior Basin south of the Missouri River including the Ohio River and Gulf Drainages. The White River was the fourth most productive river in the United States, receiving the highest yearly price per ton of shells (Coker 1919). The White River near Newport was the site of extensive commercial shell harvesting during the early 1950's.*

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* Personal Communication, Robert Leisure, 27 Oct 1986, Commercial Shell Fisherman and Buyer, Grand Glaise, Arkansas.

PART II: METHODS

12. Qualitative and semiquantitative collections for molluscs were made with a three-man diving crew supplied by the US Army Engineer District, Little Rock (Figure 3). At each site the boat was anchored and a diver equipped with

a. Dive boat

b. Retrieving mussels

Figure 3. Positioning the dive boat and retrieving mussels from the White River, Arkansas

SCUBA searched for a specific period of time (usually 15 min) for live mussels (Tables A1 and A2, Appendix A). Because of the high water velocities (often in excess of 50 cm/sec), the diver was tethered at all times. At most sites lateral motion across the current was considerably restricted. Typically, the diver moved away from the boat with the current as far as possible, then worked toward the shoreline or the main channel. Usually the boat had to be repositioned several times to ensure adequate coverage. At each site the diver provided information on current velocity, depth, substrate composition, and presence of shells and live mussels.

13. One or more nondivers searched the shoreline and shallow water at each site for shells and live mussels (Tables A2 and A3, respectively). Notes were made on physical conditions at each site, and the relative age (i.e.,

fresh or old material) of the shells. Semiquantitative samples were obtained by divers at river mile 236.2 (the Highway 67 site, Figure 4) by collecting all mussels from within a 0.25-sq-m quadrat (Table A4). High current velocity made it impossible for the diver to obtain total substrate samples. Mr. Robert Leisure, a commercial shell fisherman and buyer, worked two transects with his brail boat at river mile 236.2 (Table A5).

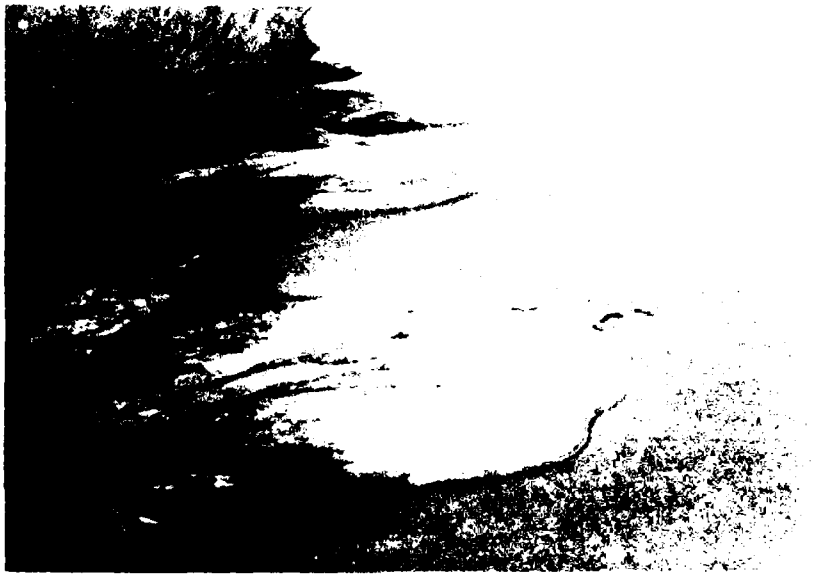

Figure 4. A dredged material disposal site on the White River, river mile 236.2

14. Live mussels obtained during the survey were identified and counted. Selected specimens were weighed (0.01 g) and total length recorded (0.1 mm). All mussels not needed for voucher specimens were returned to the White River.

PART III: RESULTS AND DISCUSSION

Molluscs of the White River

15. Thirty-one species of unionid molluscs, and the Asiatic clam, *Corbicula fluminea*, were collected from 12 dredge disposal sites on the White River in Jackson and White Counties, Arkansas (Table 1). Twenty-four species were found alive, and seven additional species were represented only as shells. The endangered pink mucket, *Lampsilis orbiculata*, and the fat pocketbook (*Potamilus capax*) were not found alive during the survey. However, fresh shells of *L. orbiculata* were found at river mile 236.2 (site 11, see Figure 1) and relict shells were found at seven additional sites (Table 2). Figures 5-8 show four of the species collected.

16. Based upon collections of shells, the molluscan fauna in this reach of the White River was dominated by the three-ridge (*Amblema plicata*), butterfly (*Ellipsaria lineolata*), ebony shell (*Fusconaia ebena*), fragile papershell (*Leptodea fragilis*), hickorynut (*Obovaria olivaria*), three-horned wartyback (*Obliquaria reflexa*), bank climber (*Plectomerus dombeyanus*), bloofer (*Potamilus purpuratus*), monkeyface (*Quadrula metanevra*), pimpleback (*Q. pustulosa*), and buckhorn (*Tritogonia verrucosa*) that were found at 10 or more of the sites (Table 1). The least common species were the deertoe (*Truncilla truncata*), pyramid pigtoe (*Pleurobema pyramidatum*, = *P. rubrum*), Ouachita kidneyshell (*Ptychobranchus occidentalis*), and pink papershell (*Potamilus laevissima*). Eight of the twelve sites had 20 or more species. Dredged areas with the highest richness were sites 1, 2, 8, 10, and 11, where 20 or more species were obtained (Figure 1, Table A2). The fewest species of shells were obtained at sites 3 and 9 where 15 and 12 species, respectively, were collected.

17. Using SCUBA and collecting by hand in shallow water, 192 live mussels were taken at 8 of the 12 sites (Tables 2 and A3). The majority of the mussels, 96.8 percent, were obtained at sites 4, 5, 8, 11, and 12 (Figure 1). The most common species were *F. ebena* (22 percent, taken at five sites), *Q. pustulosa* (26 percent, collected at six sites), *O. olivaria* (7 percent, found at two sites), and *E. lineolata* (22 percent found at five sites). A total of nine species were taken only at a single site, and eight species were represented by a single live individual.

Figure 5. *Lampsilis ventricosa* from the White River, Arkansas

Figure 6. *Obovaria olivaria* from the White River, Arkansas

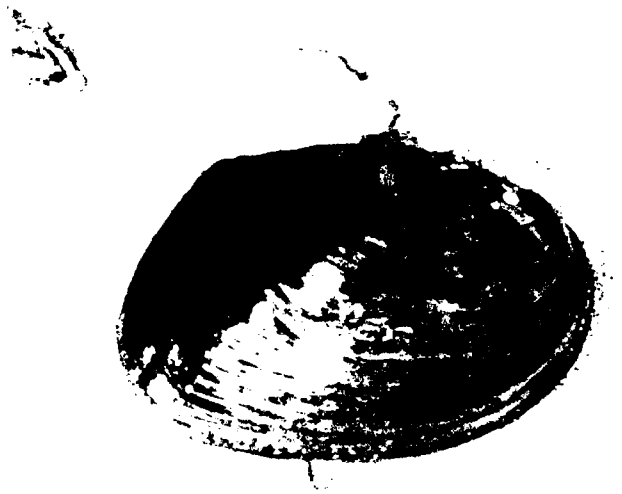

Figure 7. *Megalonaias gigantea* from the White River, Arkansas

Figure 8. [illegible] from the White River, Arkansas

18. Mussels were confined to fairly narrow (1-2 m) gravel strips parallel to the shore. They were usually in water 4 to 6 m deep and about 5 to 15 m from shore. Closer to shore the substrate consisted of mud or clay, but in deeper water toward midchannel the bottom was composed of sand and small amounts of gravel and dead shells. At site 4, a relatively large number of mussels (28 individuals representing nine species) were found in shallow water near the dredged material. At site 8, 10 species and 26 individuals were collected in mud substrate in low velocity water (<15 cm/sec) within 20 m of the shore. These mussels were on the opposite side of the river from the disposal sites in a segment that probably did not require dredging. These depositional areas supported *L. fragilis*, *P. laevissima*, and *Lasmigona complanata*, as well as lesser numbers of thick-shelled species.

19. Six semiquantitative 0.25-sq-m samples were taken at site 11 (Table A4). Unionid density was estimated to range from 4 to 44 individuals/sq m, and species richness from one to five per quadrat. These samples were dominated by *E. lineolata* (37 percent) and *Q. pustulosa* (31.2 percent); the other eight species each represented less than 10 percent of the collection. The two brail samples (Table A5) were dominated by *E. lineolata* and *O. olivaria* (both 24.3 percent), and fewer numbers of *Q. pustulosa* and *O. reflexa* (both 16.2 percent).

20. Evidence of recent recruitment (i.e. specimens that were at least half the maximum size) was noted for 10 of the 24 species collected alive in the study area (Table 1). About 10 percent of the live *O. olivaria* were subadults. For the remaining nine species, evidence of recruitment was based upon either one or a few subadults.

Community Characteristics

21. The mussel fauna of the White River near Newport, Arkansas, is moderately diverse, consisting of at least 24 species. The community is dominated by thick-shelled species (*Fusconaia* spp., *Quadrula* spp., and *E. lineolata*), which are common inhabitants of sand/gravel and mud substrate (Buchanan 1980, Parmalee 1967). Less common species, *L. fragilis*, *Potamilus laevissima*, *Anodonta grandis*, and *Lasmigona complanta*, typically collected in soft substrate (Parmalee 1967) were found in depositional zones in deep water in mud or silt.

22. Unionid communities in large rivers are usually dominated by a single species (such as the three-ridge, *A. plicata*, the ebony shell, *F. ebena*, or the washboard, *Megalonaias gigantea*), which can comprise about 50 percent of the community (Miller and Payne 1987, Payne and Miller 1987). Typically when *F. ebena* is present it is often the most abundant taxon; when absent, usually *A. plicata* or *M. gigantea* are most common. Based upon live and shell collections, and observations of commercial fishermen (Robert Leisure, personal communication), the unionid community in this reach of the White River was probably always dominated by *F. ebena*.

23. Based upon a comparison of live molluscs and shells collected from the dredge disposal area (Table 1), certain unionids have either been extirpated, or else are now extremely uncommon in the study area. Seven species (*Actinonaias ligamentina*, *Elliptio dilatata*, *L. orbiculata*, *P. rubrum*, *P. occidentalis*, *Q. metanevra*, and *T. truncata* were found as shells but not taken alive (Table 1). Of these seven species, Stein and Stansbery (1980) collected all but three (*P. occidentalis*, *P. rubrum*, and *E. dilatata*) in an intensive survey at river mile 236.2 (site 11). In their survey a diver spent more than 5 hr in the water and collected over 800 live mussels. This degree of effort should ensure collecting even the least common species; it is possible that the above three species are no longer found in this reach of the White River.

24. Live molluscs and shells in the study area were robust, with little evidence of erosion. Specimens of *A. ligamentina*, *P. occidentalis*, and *Lampsilis ventricosa* were exceptionally thick, the nacre not stained, and the periostracum mostly intact. These attributes characterize the water quality as good, with adequate dissolved calcium and moderate levels of suspended sediments which, with high velocity water, can erode shells. Cold-water releases from Bull Shoals and Norfork Lakes have a minor influence on water temperatures in this reach of the White River (Figure 2). Periodic releases of cold water from hydropower facilities have affected recruitment of unionids in the Cumberland River (Miller, Rhodes, and Tippit 1984) and the Caney Fork River, Tennessee (Miller, unpublished information).

Lampsilis orbiculata

25. *Lampsilis orbiculata* has always been reported as uncommon, although distributed over a wide area. Its range included the Niagra River at Buffalo, New York; the Illinois River in Illinois; the upper and lower Ohio River and some tributaries (Allegheny, Monongahela, Kanawha, Muskingum, Scioto, Green, Wabash, and White Rivers); the Cumberland and a tributary, the Obey River; and the Tennessee River and some of its tributaries (Clinch, Holston, French Broad, Flint, and Duck Rivers, and Limestone Creek). It has been found in the Cumberland River, Tennessee, and the lower Tennessee River below Wilson and Guntersville Dams in Alabama, and below Pickwick Dam in Tennessee, and in the Meramec River Basin, Missouri (Buchanan 1980).

26. Results of previous studies illustrate the rarity of this species. In Illinois, Parmalee (1967) reported that this species was uncommon to rare and taken only from large rivers in deep water. Buchanan (1980) reported that *L. orbiculata* was found in a variety of substrate types ranging from silt to cobble but was most common in gravel and cobble. Typically it was collected in water 0.3 to 1.5 m deep with currents ranging from 0.0 to 30 cm/sec at the bottom. *Lampsilis orbiculata* represented only 1 percent of the mussel fauna in the Meramec River Basin. The Arkansas State Highway and Transportation Department (1984) searched 1,483 sq m of bottom at a site in the Spring River and collected only six live *L. orbiculata*. Stein and Stansbery (1980) found only two *L. orbiculata* out of a total of 814 live molluscs collected during their survey. In a survey of the Black River near Pocahontas, Arkansas, 44 sites were searched and over 1,000 mussels were collected including two live *L. orbiculata* (Miller and Hartfield 1986).

27. Although gravel substrate in the study area provides suitable habitat for the endangered *L. orbiculata*, no live specimens were found during this survey. The number of relict shells collected in the dredged material disposal piles (i.e. they were dredged from the river) indicates that live *L. orbiculata* were widely distributed, although uncommon, in this reach of the river (Table 2). Commercial shell fishermen bring approximately 15 *L. orbiculata* to a local shell buyer each year. Most of these *L. orbiculata* probably originate from the study area, although some could be brought in from areas downriver. Presumably some individuals of this species are identified by the shell

fishermen and returned to the river immediately after capture (Robert Leisure, personal communication).

28. One intact set of fresh shells (the organism had died during the summer of 1986) was collected at river mile 236.2 (site 11, see Figure 1). Based upon the results of this survey and that of Stein and Stansbery (1980), the most likely site to find live *L. orbiculata* is at river mile 236.2. It is possible that live *L. orbiculata* could exist at any of the dredged sites where the relict shells were collected; however, the most valuable site for common and uncommon molluscs, as well as *L. orbiculata*, is at river mile 236.2 (Table 2).

Density

29. At site 11, mussel densities ranged from 4 to 44 individuals/sq m (based on six quantitative samples). These values can be contrasted with the upper Mississippi River, where average densities ranged from 2.8 to 202.0 organisms/sq m (based on 10 quadrats) at 15 sites (Miller and Payne 1987). The Black River, near Pocahontas, Arkansas, which has about half the discharge as the White River but is similar in other respects, has a fairly extensive mollusc fauna. Miller and Hartfield (1986) conducted a 3-day survey on that river using divers and collected over 1,000 live mussels from 44 sites. Clearly the mussel fauna of the White River in the study area can be characterized as having moderate to low densities when compared with other sites.

Effects of Dredging

30. The White River near Newport, Arkansas, has been known as one of the most productive sites in the United States for commercial quality shells (Coker 1919, Robert Leisure, personal communication). However, this fauna has been impacted by dredging for commercial navigation and harvesting by commercial shell fishermen. Currently, about eight local individuals work this reach of the river for shells on a part-time basis. In 1985 and 1986 approximately [illegible] tons and 12 tons of shells, respectively, mostly the ebony shell (*F. ebena*), were harvested from this reach of the river (Robert Leisure, personal communication). Maintenance dredging, which removes gravel substrate and live organisms, has been conducted for the last 20 years at selected sites

on an annual or as needed basis (Table 1). Commercial harvesting was, and is still being done with the brail, divers equipped with surface air supply, and for a period in the past, benthic dredges dragged from a boat. It is not possible to determine the extent that dredging, as compared with commercial harvesting methods, contributed to loss of the molluscan fauna.

31. At site 11 live mussels and fresh shells (less than 5 percent of the collection) were found that had been damaged by a hydraulic dredge. However, at sites 8 and 12 about six intact shells were found that could not have been the result of dredging in 1986 (Table 1). These individuals could have been stranded by low water or died of other causes. At sites 4 and 9, small live unionids were collected in gravel in water less than 0.5 m deep and within 3 m of shore. These juveniles could have been displaced from deep water by the dredge (possible for site 4, river mile 250.0), or could have recently invaded these dredged areas.

32. Although mussel densities have been affected by activities of man, there was evidence of recent recruitment for at least 10 species in this reach of the White River (Table 1). Juvenile mussels were found at sites 4, 9, and 11 (river miles 250.8, 239.9, and 236.2, respectively). These three sites represent the most important areas in the study area for mussels. At the latter site small mussels were collected with the brail (Table A5) and in quantitative samples (Table A4).

PART IV: SUMMARY AND CONCLUSIONS

33. The White River near Newport, Arkansas, has been well known for supporting a dense mussel fauna including commercially valuable species. Currently, the fauna is dominated by the ebony shell, *Fusconaia ebena*, in addition to three other thick-shelled species. Based upon results of this survey, three unionids (*Pleurobema pyramidatum*, *Ptychobranchus occidentalis*, and *Elliptio dilatata*) may have been extirpated from this reach of the river. The endangered *Lampsilis orbiculata* was found only as shells at 8 of the 12 study sites; however, two live individuals were collected during an intensive survey conducted in 1980 (Stein and Stansbery 1980). Dredging to maintain the navigation channel has negatively affected density and species richness of these invertebrates. In addition to dredging, the disposal of sand and gravel on existing mussel beds has been detrimental to the fauna. However, evidence of recent unionid recruitment was found for 10 of the 24 species of mussels collected during this survey. Although cold-water releases from Norfork and Bull Shoals Lakes, located upriver of the study area, could have contributed to loss of mussels, they have not eliminated the fauna, or recruitment.

34. Recently published papers contain accounts of the loss of unionid species in large rivers due to dredging, sewage effluents, or other activities of man (Horne and McIntosh 1979, Klippel and Parmalee 1979, Strayer 1980, Taylor and Hughart 1981, Taylor and Spurlock 1982, Neves and Zale 1982, Clarke 1986). While the mussels of the White River near Newport have been affected by water resource development, sampling with the brail, with SCUBA, and careful searches along the shore has demonstrated the presence of juveniles of at least ten species. This indicates that while the fauna has been severely stressed, it has the potential to recover if suitable substrate is available.

REFERENCES

Aggus, L. R., Moraia, D. I., and Baker, R. F. 1978. "Evaluation of the Trout Fishery in the Tailwater of Bull Shoals Reservoir, 1971-73," Proceedings of the Annual Conference of the Southeastern Fisheries and Wildlife Agencies, Vol 31, pp 565-573.

Arkansas State Highway and Transportation Department. 1984. "Relocation of the Pink Mucket Pearly Mussel (*Lampsilis orbiculata*) in the Spring River near Ravenden, Lawrence County, Arkansas," Little Rock, Ark.

Buchanan, A. C. 1980. "Mussels of the Meramec River Basin, Missouri," Aquatic Series No. 17, Missouri Department of Conservation, Jefferson City, Mo.

Clarke, A. H. 1986. "Unionidae of the Upper Connecticut River, A Vanishing Resource," The Nautilus, Vol 100, pp 49-53.

Coker, R. E. 1919. "Freshwater Mussels and Mussel Industries of the United States," Bulletin of the Bureau of Fisheries, Vol 36, pp 11-89.

Gordon, M. E. 1982. "Mollusca of the White River, Arkansas and Missouri," The Southwestern Naturalist, Vol 27, pp 347-352.

Gordon, M. E., Kraemer, L. R., and Brown, A. V. 1979. "Unionidae of Arkansas, Historical Review, Checklist and Observations on Distributional Pattern," Bulletin of the American Malacological Union (1979), pp 31-37.

Hinkley, A. A. 1916. "New Fresh-Water Shells from the Ozark Mountains," Proceedings of the U. S. National Museum, Vol 49, pp 587-589.

Hoffman, C. E., and Kilambi, R. V. 1971. "Environmental Changes Produced by Cold-water Outlets from Three Arkansas Reservoirs," Arkansas Water Research Center, Pub. No. 5, University of Arkansas, Fayetteville, Ark.

Horne, F. R., and McIntosh, S. 1979. "Factors Influencing Distribution of Mussels in the Blanco River of Central Texas," The Nautilus, Vol 94, pp 119-133.

Klippel, W. E., and Parmalee, P. W. 1979. "The Naiad Fauna of Lake Springfield, Illinois: An Assessment After Two Decades," The Nautilus, Vol 94, pp 189-197.

Kraemer, L. R. 1980 (Mar). "*Ironitera (Potamilus) capax* and the Benthic Community Structure in the White River at St. Charles, Arkansas," Report to the Environmental Division, Arkansas State Highway and Transportation Department, Little Rock, Ark.

Miller, A. C., and Hartfield, P. D. 1986. "A Survey for Live Mussels in the Black and Spring Rivers, Arkansas," Miscellaneous Paper EL-86-7, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Miller, A. C., and Payne, B. S. 1987. "Quantitative Sampling to Characterize Freshwater Mussel Populations and Communities," Submitted for Publication in the Bulletin of the American Malacological Union.

Miller, A. C., Rhodes, L., and Tippit, R. 1984. "Changes in the Naiad Fauna of the Cumberland River Below Lake Cumberland in Central Kentucky," The Nautilus, Vol 98, pp 107-110.

Neves, R. J., and Zale, A. V. 1982. "Freshwater Mussels (Unionidae) of Big Moccasin Creek, Southeastern Virginia," The Nautilus, Vol 96, pp 52-54.

Parmalee, P. W. 1967. "The Fresh-Water Mussels of Illinois," Illinois State Museum Popular Science Series 8, pp 1-108.

Payne, B. S., and Miller, A. C. 1987. A Quantitative Study of Molluscs in the Lower Ohio River near Olmsted, Illinois. Journal article in preparation.

Stein, C. B., and Stansbery, D. H. 1980. "Final Report on the Distribution of the Naiad Mollusks of the White River in the Vicinity of the Proposed U. S. Route 67 Bridge, Jackson County, Arkansas," A Letter Report submitted to the Arkansas State Highway and Transportation Department, Little Rock, Ark.

Strayer, D. 1980. "The Freshwater Mussels (Bivalvia:Unionidae) of the Clinton River, Michigan, With Comments on Man's Impact on the Fauna, 1870-1978," The Nautilus, Vol 94, pp 142-149.

Taylor, R. W., and Hughart, R. C. 1981. "The Freshwater Naiads of Elk River, With a Comparison of Earlier Collections," The Nautilus, Vol 95, pp 21-25.

Taylor, R. W., and Spurlock, B. D. 1982. "The Changing Ohio River Naiad Fauna: A Comparison of Early Indian Middens with Today," The Nautilus, Vol 96, pp 49-51.

US Geological Survey. 1985. "Water Resource Data, Arkansas, Water Year 1985," US Geological Survey Water-Data Report AR-85-1, Little Rock, Ark.

Table 1

Bivalves Collected on the White River, October 1986

Scientific Name	Common Name	Shells*	Live*	Recruitment**
Actinoaias ligamentina	Mucket, grandma	U	N	N
Amblema plicata	Three-ridge	C	U	Y
Anodonata grandis grandis	Common floater	U	U	N
Cyprogenia aberti	Western fanshell	U	U	N
Elliptio dilatata	Spike, ladyfinger	U	N	N
Ellipsaria lineolata	Butterfly	A	A	N
Fusconaia ebena	Ebony shell	A	A	N
Fusconaia flava	Wabash pigtoe	U	U	N
Lampsilis orbiculata	Pink mucket, Higginsi	U	N	N
Lampsilis teres	Yellow sandshell	U	U	N
Lampsilis ventricosa	Plain pocketbook, grandma	A	A	Y
Lasmigona complanata	White heelsplitter	N	U	Y
Leptodea fragilis	Fragile papershell	U	U	Y
Ligumia recta	Black sandshell	U	U	N
Megalonaias gigantea	Washboard	U	U	N
Obliquaria reflexa	Three-horned wartyback	U	U	Y
Obovaria olivaria	Hickorynut, eggshell	A	A	Y
Plectomerus dombeyanus	Ohio River pigtoe	U	U	N
Pleurobema cordatum	Pyramid pigtoe	U	N	N
Pleurobema pyramidatum	Pink papershell	U	U	Y
Potamilus laevissima	Bank climber	U	U	N
Potamilus purpuratus	Bloofer	U	U	Y
Ptychobranchus occidentalis	Ouachita kidneyshell	U	N	N
Quadrula cylindrica	Rabbitsfoot, cucumber	U	U	Y
Quadrula metanevra	Monkeyface	U	N	N
Quadrula nodulata	Wartyback	U	U	Y
Quadrula pustulosa	Pimpleback	A	A	Y
Quadrula quadrula	Mapleleaf	U	U	N
Tritogonia verrucosa	Buckhorn	U	U	Y
Truncilla truncata	Deertoe	U	N	N
Corbicula fluminea	Asiatic clam	U	U	Y
Total species		31	24	

* A = abundant; C = common; U = uncommon; N = not found.

** Recruitment: Y = yes; N = no.

Table 2

Summary Data for Bivalves Collected at Dredge Disposal Sites on the White River, 27-30 October 1986

Site No.	River Mile*	No. of Species		Dredging Schedule**	Last Dredged	Notes
		Shells	Live			
1	254.3	25	1	2	7/86	Relict shells *L. orbiculata*
2	254.0	20	3	1	7/86	Relict shells *L. orbiculata*
3	252.8	15	--	1	7/86	High density and richness; relict *L. orbiculata*
4a	250.8	18	--	--	8/85	Shells uncommon
4b	250.2	18	--	--	8/85	Shells uncommon
4c	250.0	18	10	1	7/86	Shells uncommon, relict *L. orbiculata*
5	248.7	19	7	2	7/86	Relict shells
6	245.8	16	--	3	7/82	Shells uncommon, relict *L. orbiculata*
7	244.6	12	--	3	7/82	Shells uncommon
8	241.9	26	10	1	8/85	Fresh shells, relict *L. orbiculata*
9	239.9	12	2	2	--	High density
10	239.2	22	--	2	7/86	High density, relict *L. orbiculata*
11	236.2	27	13	2	10/80	High density, richness, fresh *L. orbiculata* shells
12	230.8	22	9	2	10/72	Fresh shells

* River miles are approximations; see Figure 1.

** Dredging schedule: 1 = yearly; 2 = every other year; 3 = every third year.

APPENDIX A: SUMMARY DATA

Table A1

Summary Data for Live Molluscs, Collected by SCUBA Diving and by Hand in Shallow Water, 27-30 October 1986

Site	River Mile	Bank*	Replicate	Method**	No. of Species	No. of Individuals	Notes
1	254.6	R(25)†	1	D(15)†	--	--	Sand, gravel
1	254.65	R(20)	2	D(15)	--	--	Sand, gravel
1	254.4	R(25)	3	D(20)	1	1	Mud (6-10 cm) over sand
2	254.2	R(50)	1	D(15)	3	3	Mud, gravel
3	253.0	R(25)	1	D(15)	--	--	Gravel, few dead shells
4	250.6	R(15)	1	D(15)	1	1	Sand, gravel
4	250.7	L(25)	2	D(15)	--	--	Gravel from dredge
4	250.7	C(100)	3	D(10)	--	--	Gravel, few shells
4	250.7	R(75)	4	D(10)	--	--	Gravel
4	250.8	L(25)	5	D(10)	--	--	Sand, mud, no shells
4	250.6	L	1	HC	9	24	Gravel from dredge
5	248.6	R(20)	1	D(15)	1	1	Mud, gravel
5	248.6	R(30)	2	D(30)	7	21	Gravel
6	245.7	C(100)	1	D(13)	--	--	Sand
6	246.0	R(20)	2	D(14)	--	--	Sand
7	244.3	L(50)	1	D(15)	--	--	Sand
8	242.8	R(75)	1	D(9)	--	--	Sand
8	242.8	R(50)	2	D(10)	--	--	Sand
8	241.9	R(20)	3	D(6)	--	--	Gravel from dredge
8	242.9	L(20)	4	D(15)	6	19	Mud
8	243.1	L(40)	5	D(15)	--	--	Mud
8	243.1	L	1	HC	6	7	Mud
9	239.8	L(35)	1	D(15)	1	1	Sand, gravel
9	240.0	R	1	HC	1	1	Gravel from dredge
10	239.0	R(50)	1	D(3)	--	--	Clay
10	239.1	R(20)	2	D(5)	--	--	Clay
11	236.0	L(15)	1	D(19)	8	27	Gravel
11	236.0	L(15)	2	D(15)	8	13	Gravel
11	236.0	R	1	HC	2	3	Gravel from dredge
12	230.7	L(30)	1	D(15)	7	34	Gravel
12	230.7	L(20)	2	D(20)	7	33	Gravel
12	230.7	R	1	HC	2	3	Gravel from dredge

* R = Right bank; L = Left bank; C = Center.
** D = Diver collected; HC = Hand collected.
† Numbers in parentheses refer to distance from bank in feet.

Table A2

Summary Data by Site for Shells Collected on Shore or in Shallow Water by Hand 27-30 October 1986 (X = Present)

Species	Site 1	2	3	4	5	6	7	8	9	10	11	12	Total Sites
Actinonaias ligamentina	X	X	--	--	X	--	--	--	--	X	X	X	6
Amblema plicata	X	X	X	X	X	X	--	X	X	X	X	X	11
Arcidonata grandis grandis	--	--	--	--	--	--	--	X	--	--	--	--	1
Cyprogenia aberti	X	X	X	X	--	X	--	X	--	--	X	--	7
Elliptio dilatata	--	--	--	--	--	--	--	--	--	X	X	X	3
Ellipsaria lineolata	X	X	X	X	X	X	X	X	X	X	X	X	12
Fusconaia ebena	X	X	X	X	X	X	X	X	X	X	X	X	12
Fusconaia flava	X	X	--	X	X	--	--	X	--	X	--	X	7
Lampsilis orbiculata	X	X	X	X	--	X	--	X	--	X	X	--	8
Lampsilis teres	X	X	X	--	X	--	--	X	--	X	X	X	8
Lampsilis ventricosa	X	--	--	X	--	X	X	X	--	X	X	X	8
Lasmigona complanata	X	--	--	--	--	--	--	--	--	--	X	--	2
Leptodea fragilis	X	--	X	X	X	X	X	X	X	X	X	--	10
Ligumia recta	X	X	X	X	--	--	X	X	--	--	X	--	7
Megalonaias gigantea	X	--	--	--	--	--	--	X	--	X	X	--	4
Obliquaria reflexa	X	X	X	X	X	X	--	X	X	X	X	X	11
Obovaria olivaria	X	X	X	X	X	--	--	--	X	X	X	--	8
Plectomerus dombeyanus	X	X	X	X	X	--	X	X	--	X	X	X	10
Pleurobema cordatum	X	--	X	--	X	--	--	--	--	X	X	X	6
Pleurobema pyramidatum	--	X	--	--	--	--	--	--	--	--	X	--	2
Potamilus laevissima	--	--	--	--	--	--	--	--	--	X	--	--	1
Potamilus purpuratus	X	X	--	X	X	X	X	X	--	X	X	X	10
Ptychobranchus occidentalis	--	--	--	--	--	--	--	X	--	--	--	--	1
Quadrula cylindrica	X	X	--	X	--	X	--	X	X	X	X	X	9
Quadrula metanevra	X	X	X	X	X	X	--	X	X	X	X	--	10
Quadrula nodulata	X	--	--	--	X	X	X	X	X	--	X	X	8
Quadrula pustulosa	X	X	X	X	X	X	X	X	X	X	X	X	12
Quadrula quadrula	X	X	--	--	X	X	--	X	X	X	X	--	8
Tritogonia verrucosa	X	X	X	X	X	X	X	X	--	--	X	X	10
Truncilla truncata	X	X	--	X	X	X	--	X	--	--	X	X	8
Corbicula fluminea	--	--	--	--	--	--	X	X	X	--	--	--	3
Total species	25	20	15	18	18	16	11	24	12	21	26	17	

NOTE: This table represents fresh shells and relicts. Live specimens (Tables A1 and A3) were found as relicts and fresh shells. With the exception of several fresh *L. orbiculata* collected at river mile 236.2, species not found alive were represented by relict shells.

Table A3

Live Molluscs Collected by SCUBA or by Hand in Shallow Water

27-30 October 1986

Species	Site 1	2	4	5	8	9	11	12	Total Sites	Total Individuals	Percent
Actinonaias ligamentina	--	--	--	--	--	--	--	--	--	--	--
Amblema plicata	--	--	--	4	--	1	1	--	3	6	3.12
Anodonata grandis grandis	--	--	--	--	1	--	--	--	1	1	0.52
Cyprogenia aberti	--	--	--	--	--	--	1	--	1	1	0.52
Elliptio dilatata	--	--	--	--	--	--	--	--	--	--	--
Ellipsaria lineolata	--	--	--	--	8	--	9	2	3	19	9.89
Fusconaia ebena	--	--	1	--	1	1	5	35	5	43	22.39
Fusconaia flava	--	--	--	--	1	--	2	2	3	5	2.60
Lampsilis orbiculata	--	--	--	--	--	--	--	--	--	--	--
Lampsilis teres	--	--	1	--	--	--	--	--	1	1	0.52
Lampsilis ventricosa	--	--	5	--	--	--	--	2	2	7	3.64
Lasmigona complanata	--	1	--	--	1	--	--	--	2	2	1.04
Leptodea fragilis	--	--	1	--	--	--	--	--	1	1	0.52
Ligumia recta	--	--	--	--	--	--	--	--	--	--	--
Megalonaias gigantea	--	--	--	1	--	--	1	2	3	4	2.08
Obliquaria reflexa	--	1	1	4	2	--	2	--	5	10	5.21
Obovaria olivaria	--	--	12	2	--	--	--	--	2	14	7.29
Plectomerus dombeyanus	--	--	--	--	--	--	2	--	1	2	1.04
Pleurobema cordatum	--	--	--	1	1	--	--	--	2	2	1.04
Pleurobema pyramidatum	--	--	--	--	--	--	--	--	--	--	--
Potamilus laevissima	1	--	--	--	--	--	--	--	1	1	0.52
Potamilus purpuratus	--	--	1	--	1	--	--	1	3	3	1.56
Ptychobranchus occidentalis	--	--	--	--	--	--	--	--	--	--	--
Quadrula cylindrica	--	--	--	--	--	--	--	--	--	--	--
Quadrula metanevra	--	--	--	--	--	--	1	4	2	5	2.66
Quadrula rodulata	--	--	--	--	1	--	--	1	2	2	1.04
Quadrula pustulosa	--	1	1	9	9	--	15	15	6	50	26.04
Quadrula quadrula	--	--	1	1	--	--	2	6	4	10	5.21
Tritogonia verrucosa	--	--	1	--	--	--	--	--	1	1	0.52

(Continued)

Table A3 (Concluded)

Species	Site 1	2	4	5	8	9	11	12	Total Sites	Total Individuals	Percent
Truncilla truncata	--	--	--	--	--	--	1	--	1	1	0.52
Corbicula fluminea	--	--	--	--	--	--	1	--	1	1	0.52
Total species	1	3	10	7	10	2	13	10		24	
Total individuals	1	3	25	22	26	2	43	70		192	

Table A4

Summary Data by Site for Molluscs Collected in 0.25-sq-m Quadrats, Using SCUBA Divers, at River Mile 236, 31 October 1986

Species	Site 1	2	3	4	5	6	Total Individuals	Percent
Ellipsaria lineolata	--	7	2	2	1	--	12	37.5
Fusconaia ebena	1	--	--	--	1	--	2	6.2
Leptodea fragilis	--	1	--	1	--	--	2	6.2
Obliquaria reflexa	--	--	1	1	--	1	3	9.4
Potamilus purpuratus	--	1	--	--	--	--	1	3.1
Quadrula pustulosa	1	1	1	7	--	--	10	31.2
Quadrula quadrula	--	--	1	--	--	--	1	3.1
Tritogonia verrucosa	--	1	--	--	--	--	1	3.1
Total species	2	5	4	4	2	1		
Total individuals	2	11	5	11	2	1		
No./sq m	8	44	20	44	8	4		

Table A5

Summary Data for Molluscs Collected With A Brail by Mr. Robert Leisure, River Mile 236, 30 October 1986

Species	Collection No. 1	Collection No. 2	Total Individuals	Percent	Minimum Length, mm
Amblema plicata	1	--	1	2.7	114.2
Ellipsaria lineolata	7	2	9	24.3	67.9
Fusconaia ebena	--	1	1	2.7	80.8
Lampsilis ventricosa	1	1	2	5.4	21.0
Obliquaria reflexa	6	--	6	16.2	46.5
Obovaria olivaria	5	4	9	24.3	40.7
Quadrula cylindrica	1	--	1	2.7	59.2
Quadrula pustulosa	4	2	6	16.2	60.0
Quadrula quadrula	2	--	2	5.4	67.5
Total species	8	5			
Total individuals	27	10			

END

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